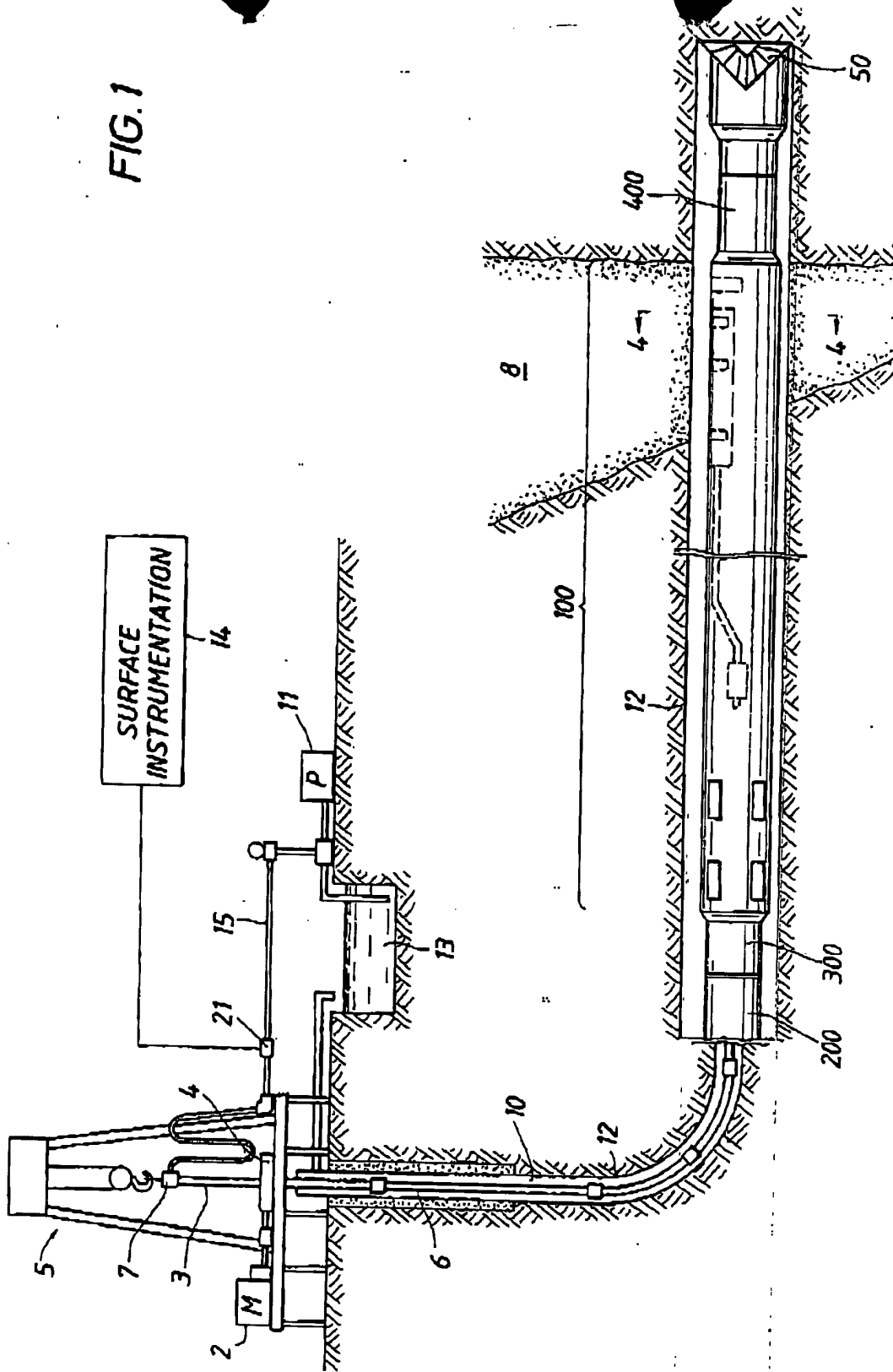


FIG. 1



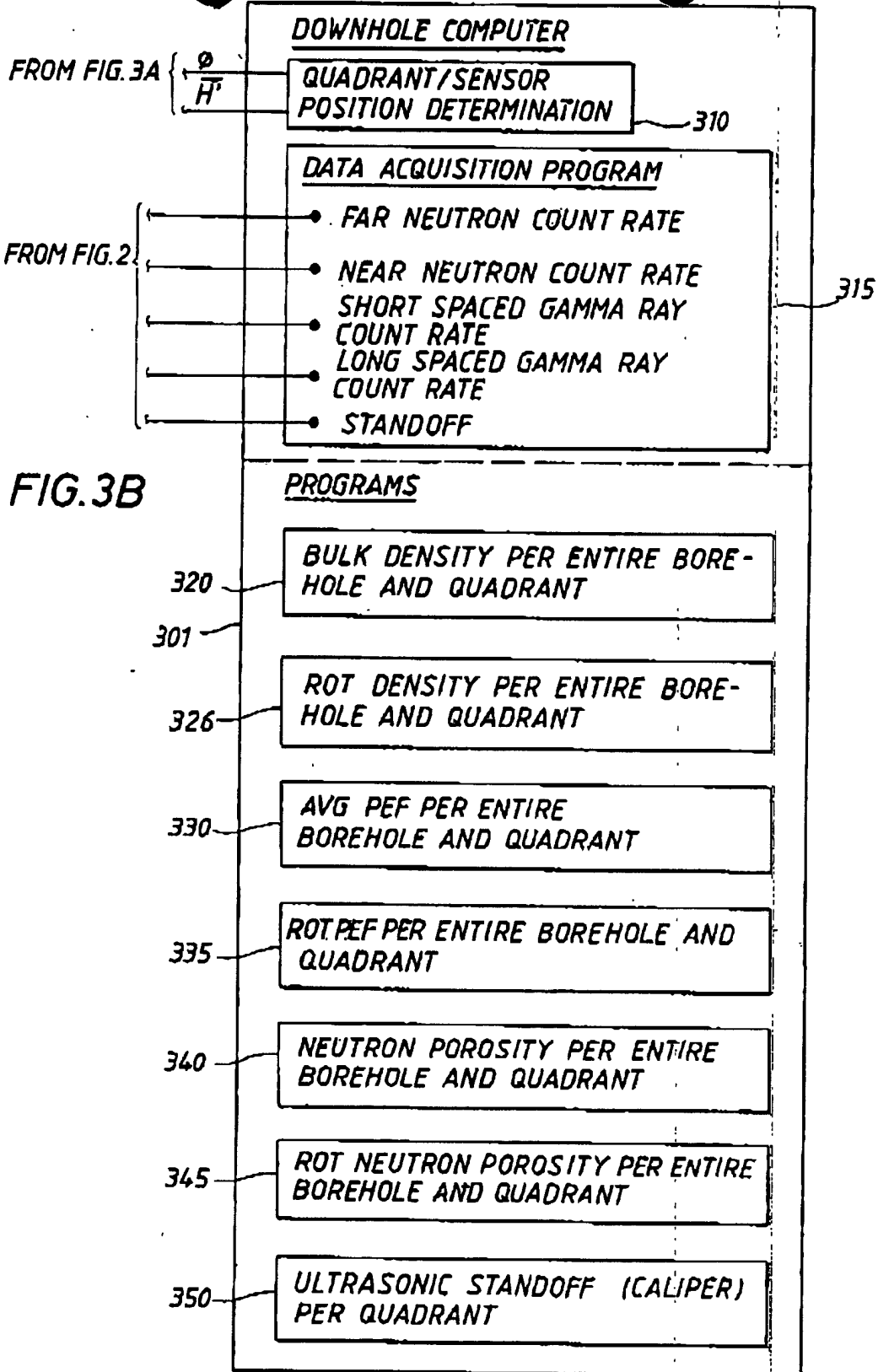


FIG. 4A

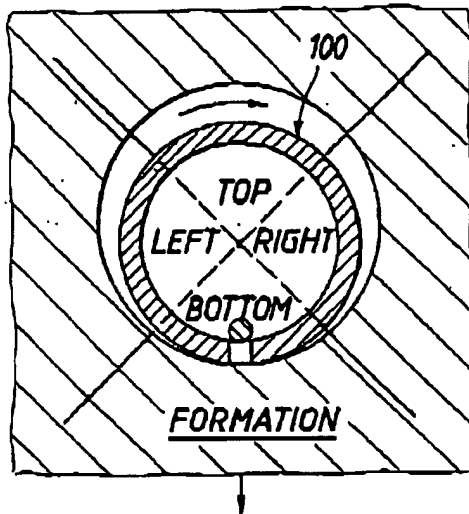


FIG. 4B

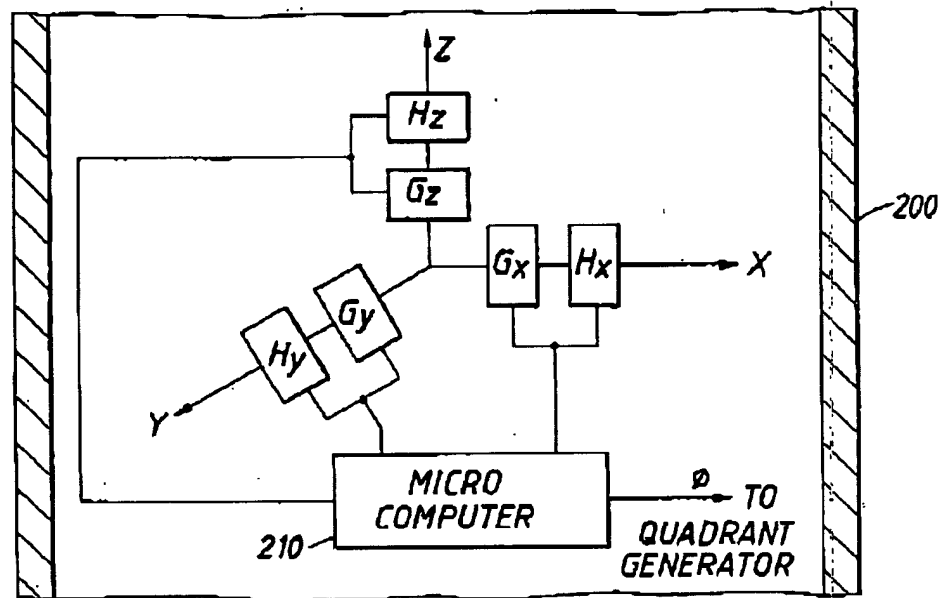
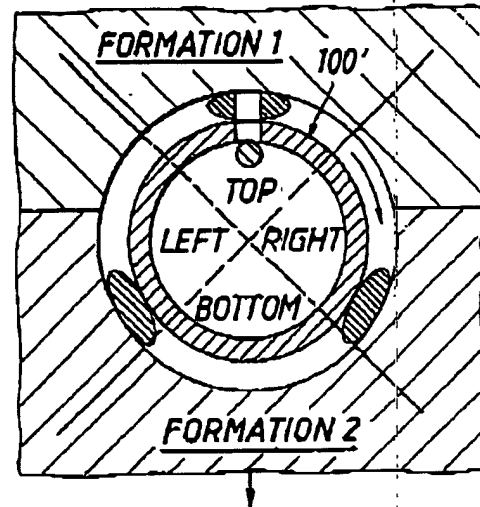


FIG. 5A

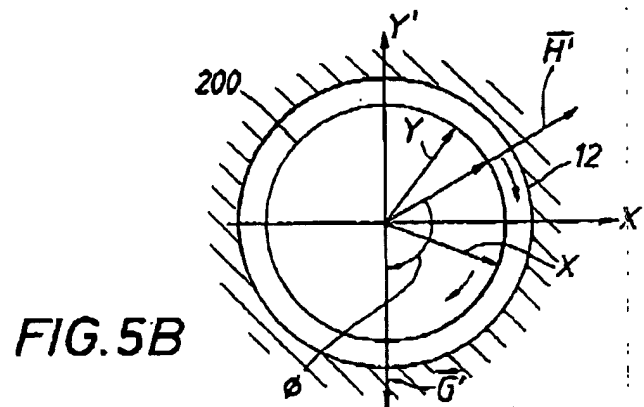
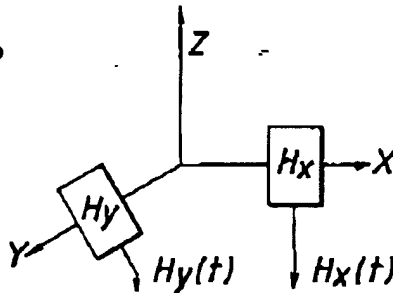


FIG. 5B

FIG. 6A

MAGNETOMETER
SECTIONQUADRANT/SENSOR POSITION DETERMINATION
COMPUTER PROGRAMDETERMINE DOWN DIRECTION

- DETERMINE $\vec{H}(t)$ VECTOR FROM $H_x(t)$, $H_y(t)$, $\Delta\theta(t)$

- DETERMINE DOWN DIRECTION ANGLE

$$\theta = \cos^{-1} \frac{H_x(t)}{(H_x^2 + H_y^2)^{1/2}}$$

ϕ → $\Delta\vec{H}(t) = \theta(t)$ AS MEASURED FROM TOOL X-AXIS
 $\Delta\vec{D}(t) = \theta(t) - \phi$ AS MEASURED FROM TOOL X-AXIS

- DETERMINE BOTTOM QUADRANT

$$Q_{BOT}(t) = \Delta\vec{D}(t) - 45^\circ \text{ TO } \Delta\vec{D}(t) + 45^\circ$$

$$Q_{LEFT}(t) = \Delta\vec{D}(t) + 45^\circ \text{ TO } \Delta\vec{D}(t) + 135^\circ$$

$$Q_{TOP}(t) = \Delta\vec{D}(t) + 135^\circ \text{ TO } \Delta\vec{D}(t) + 225^\circ$$

$$Q_{RIGHT}(t) = \Delta\vec{D}(t) + 225^\circ \text{ TO } \Delta\vec{D}(t) - 45^\circ$$

- DETERMINE QUADRANT OF SENSOR

$\Delta\vec{S}(t)$ IS MEASURED FROM X-AXIS AND $\vec{H}(t)$ VECTOR

$\Delta\vec{S}$ IS α DEGREES FROM X-AXIS

$\Delta\vec{H}(t)$ IS $\theta(t)$ DEGREES FROM X-AXIS

$\Delta\vec{S}(t) = \alpha$ AS MEASURED FROM X-AXIS IS

IN Q_{BOT} WHEN $\Delta\vec{S}(t) = \alpha$ IS BETWEEN $\theta(t) - \phi - 45^\circ$ AND $\theta(t) - \phi + 45^\circ$, ETC.

FIG. 6B

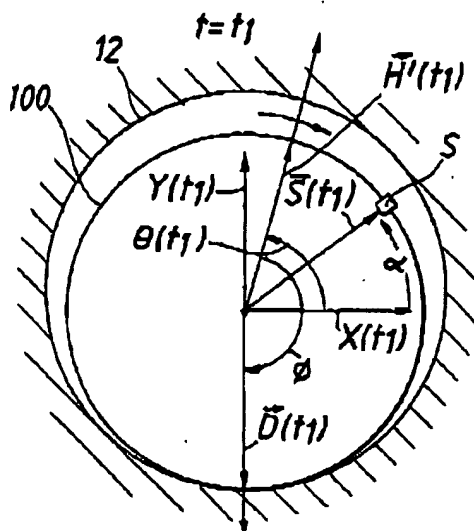


FIG. 6C

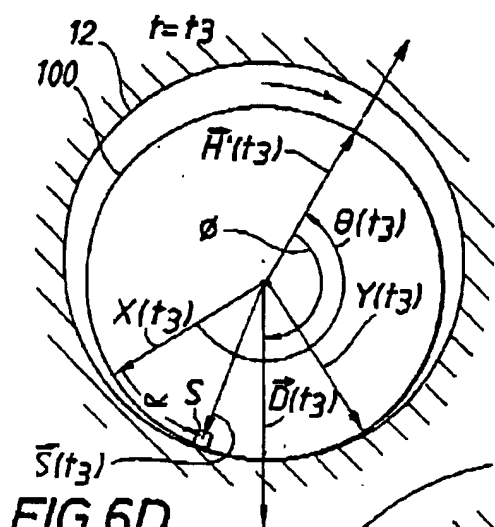
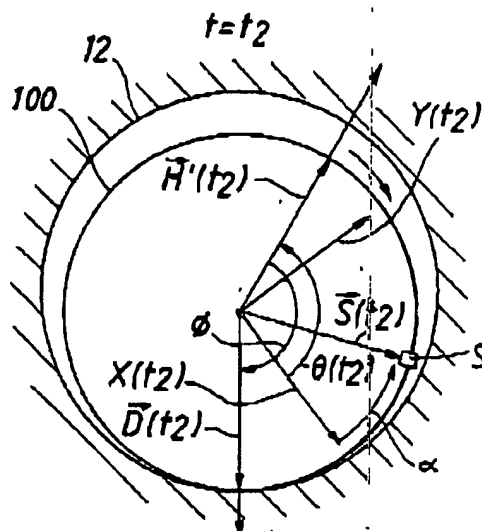


FIG. 6D

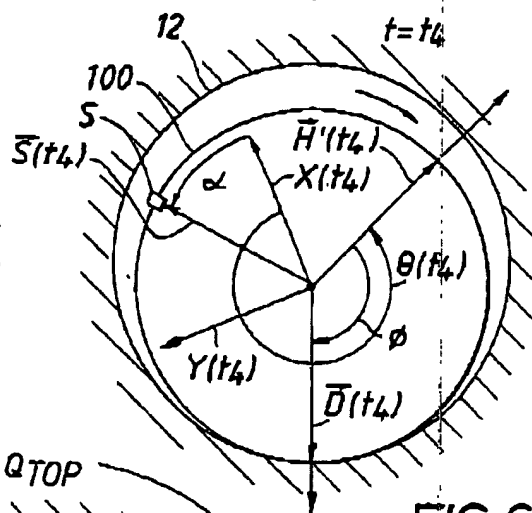


FIG. 6E

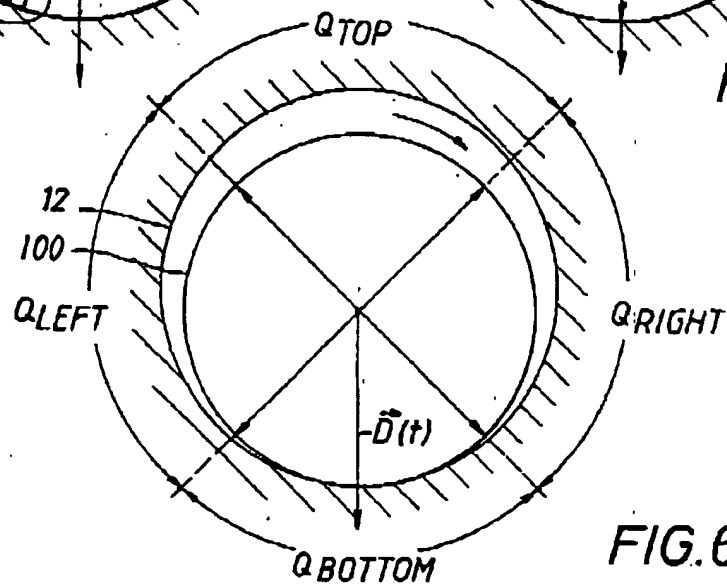


FIG. 6F

FIG. 7A

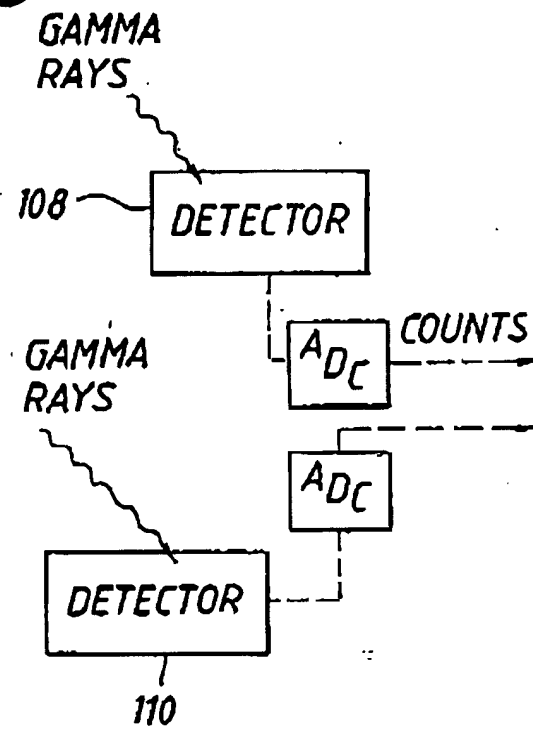


FIG. 7B

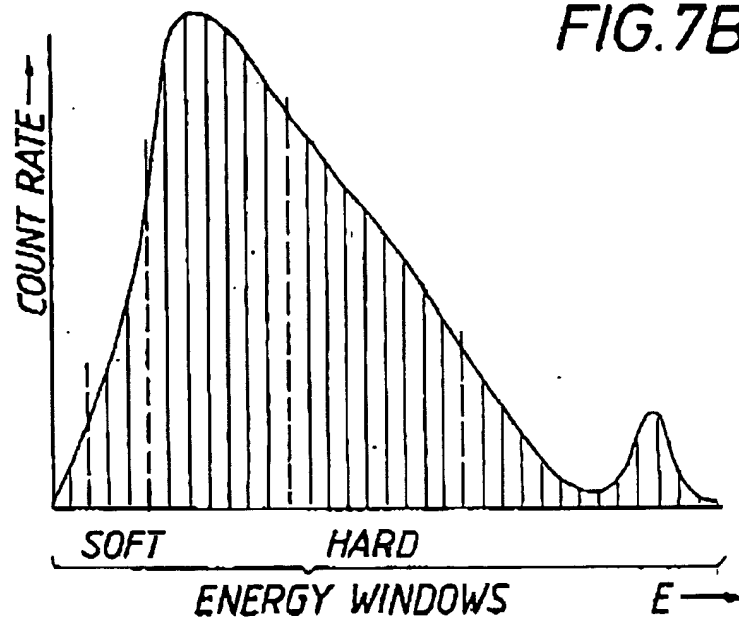


FIG. 8

315

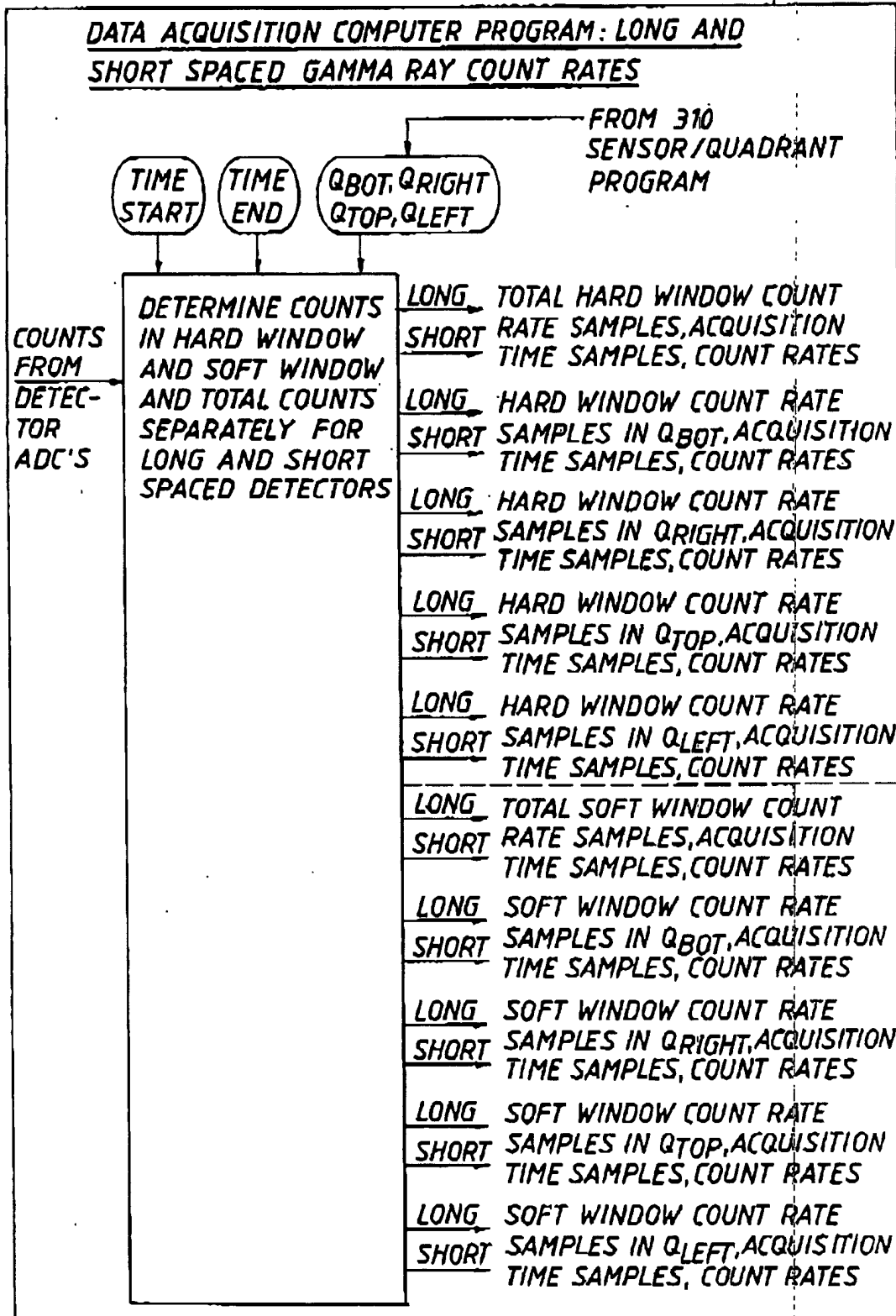


FIG. 9

320

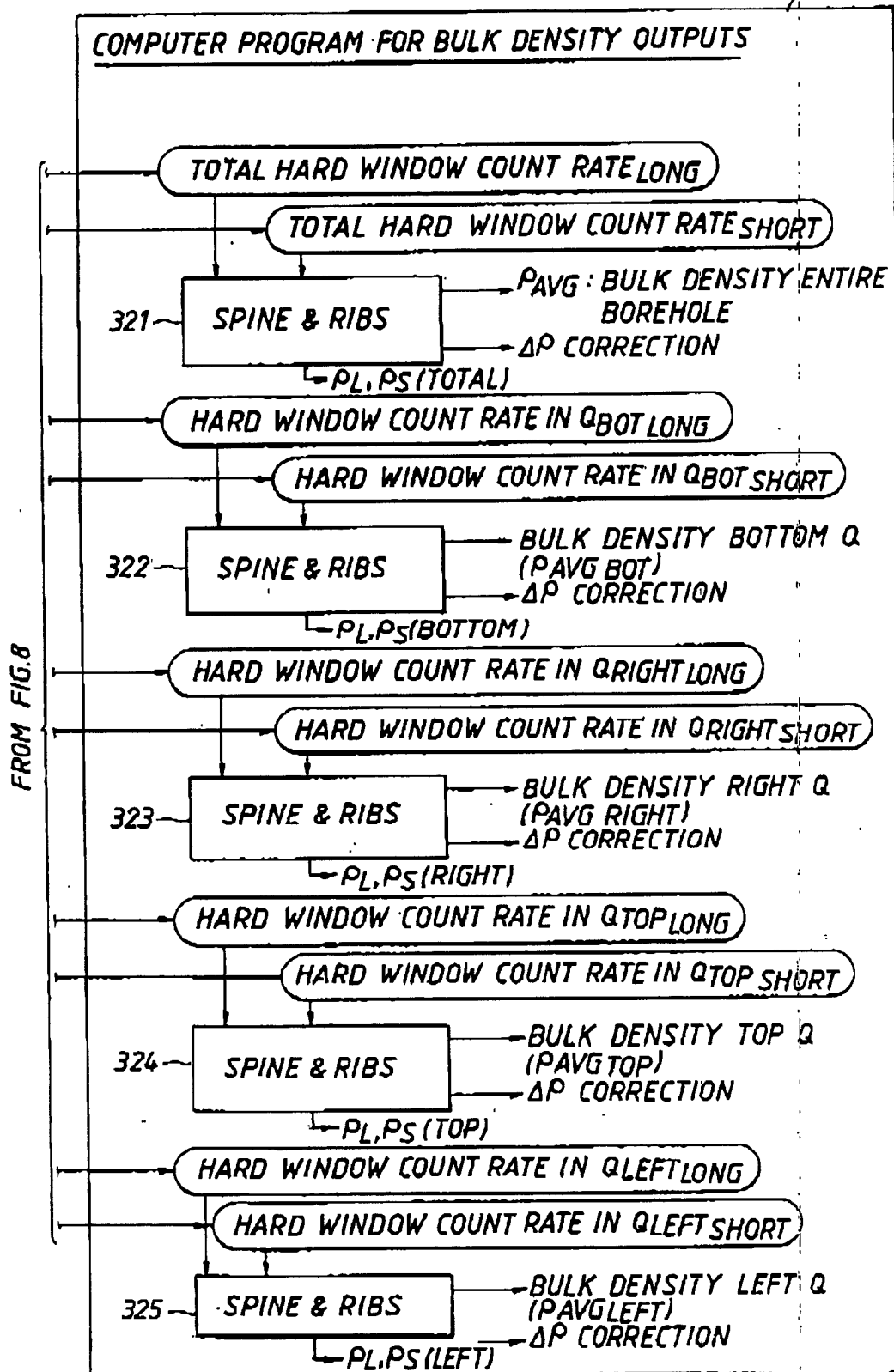


FIG. 10A-1

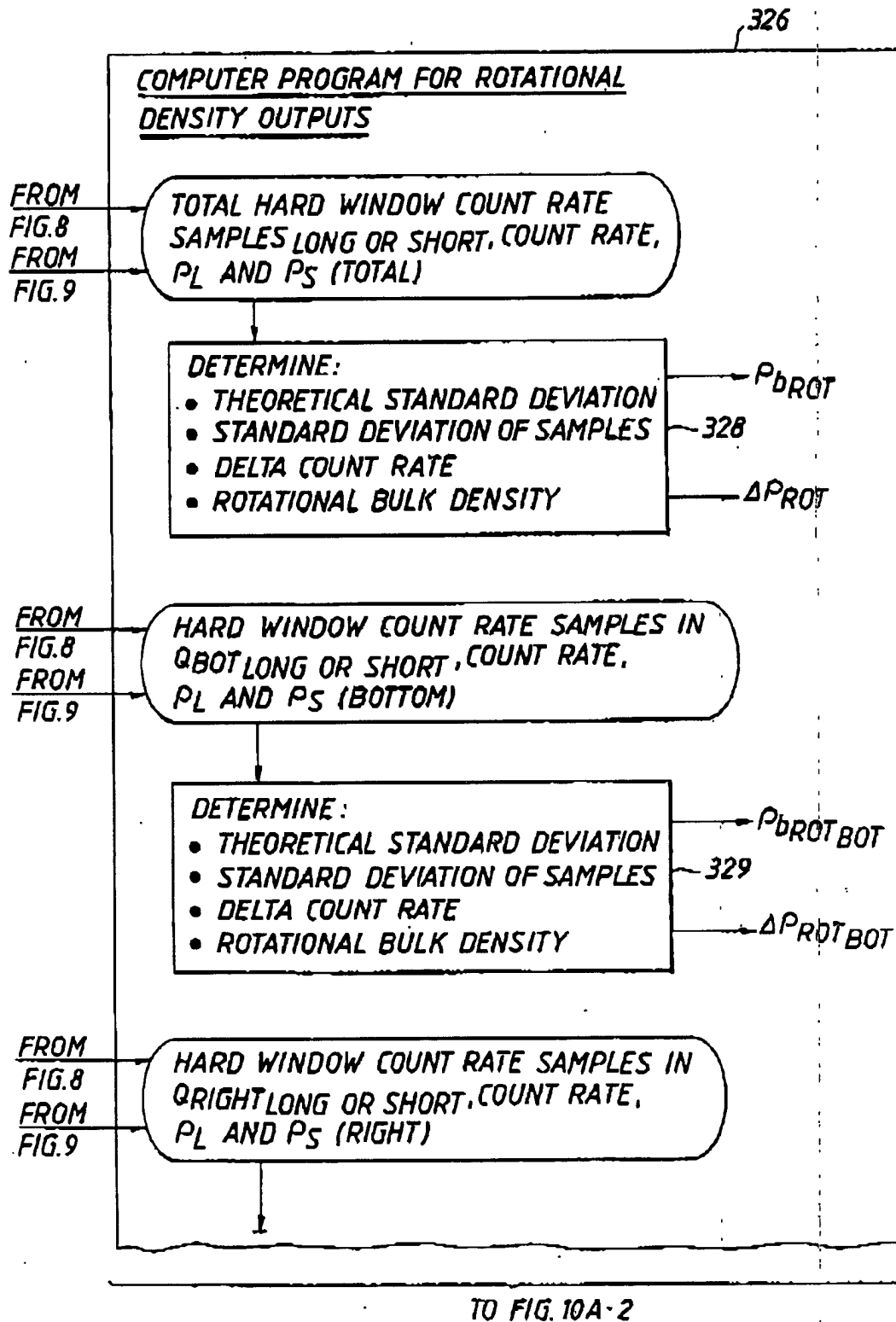
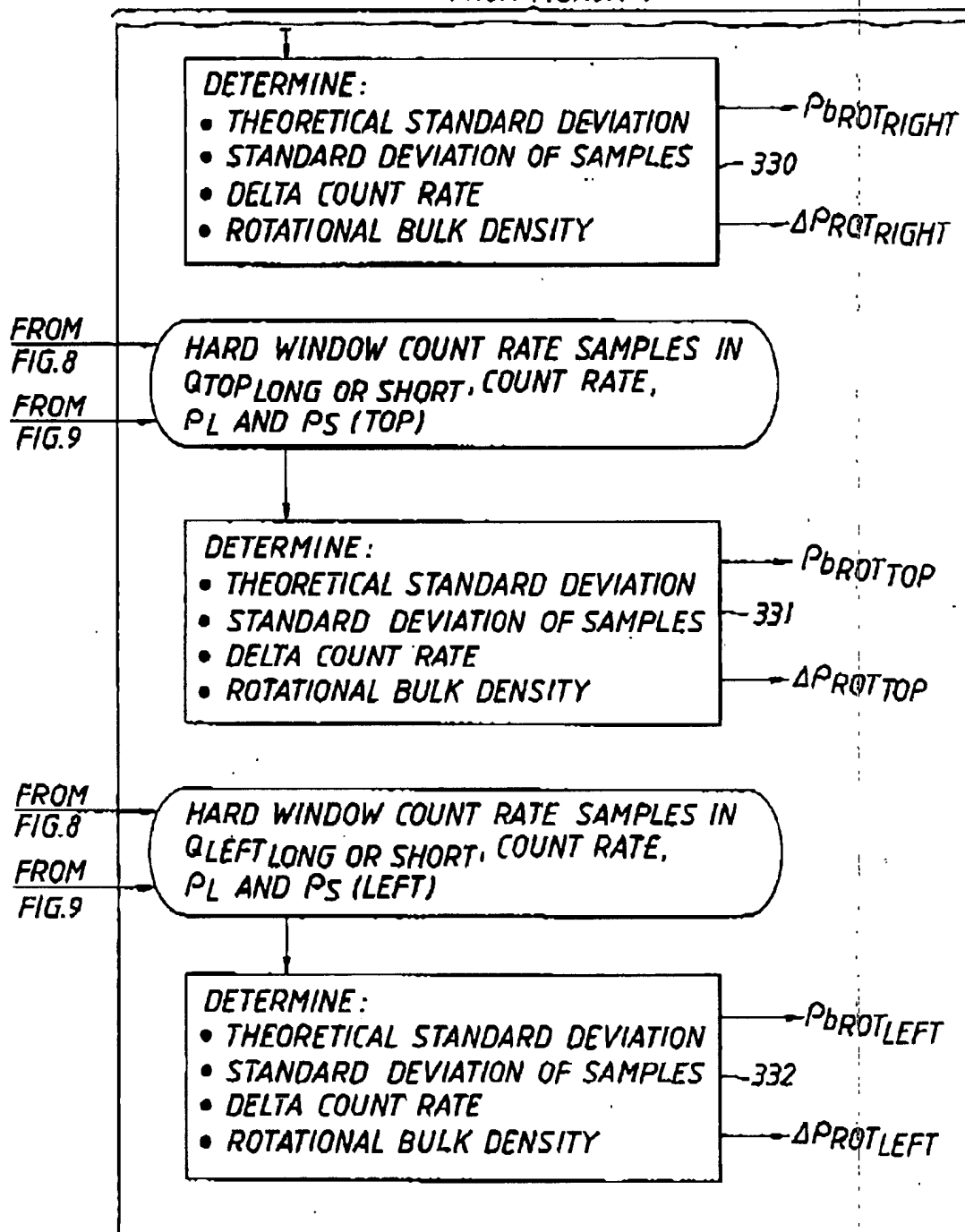


FIG. 10A-2

FROM FIG. 10A-1



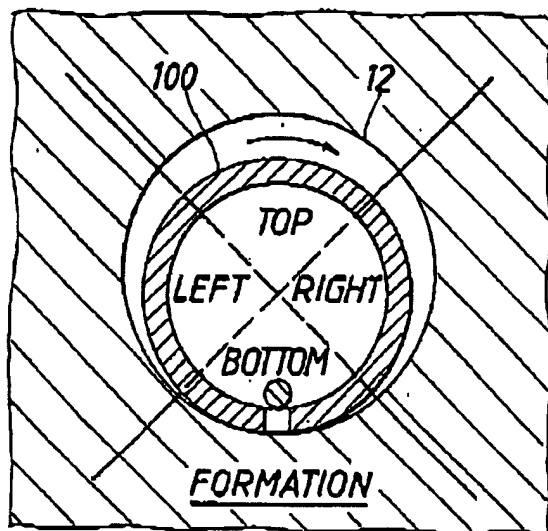


FIG. 10B

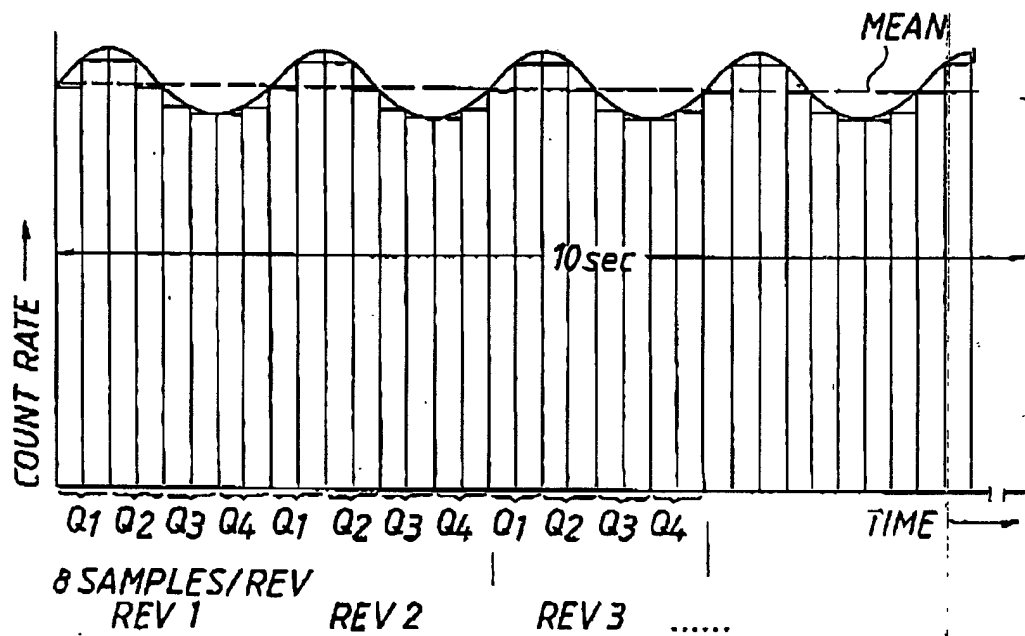
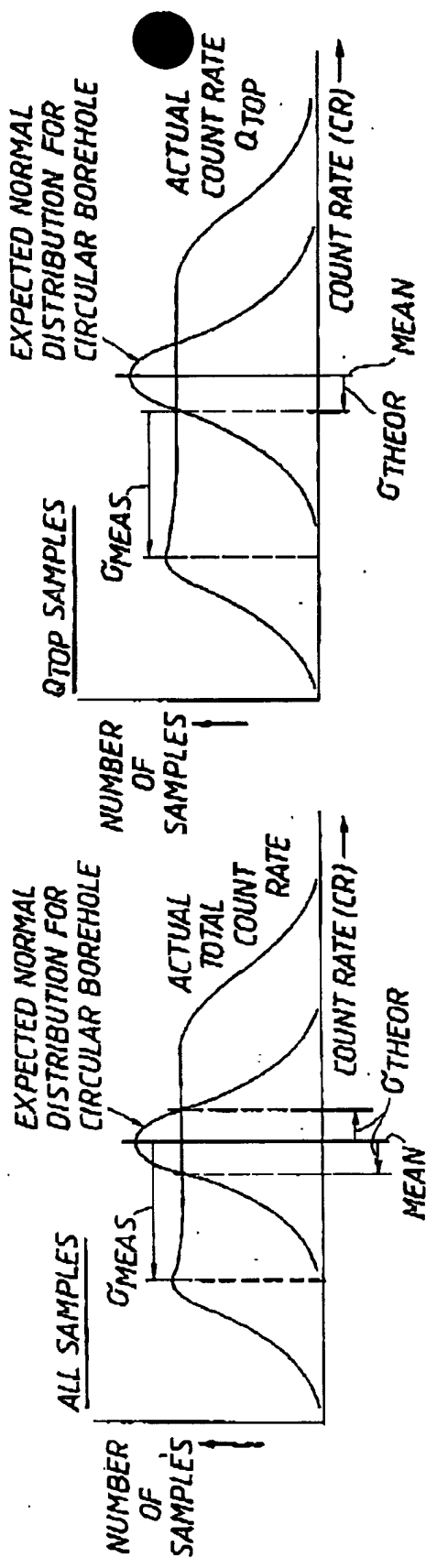


FIG. 10C



$$\Delta CR = A \sqrt{G^2_{MEAS} - G^2_{THEOR}}$$

$$\Delta PROT = (ds) \left[\ln \left(\frac{CR + \Delta CR}{CR - \Delta CR} \right) \right]$$

$$P_{bROT} = DP_L + EPS + F \Delta PROT$$

PL = LONG SPACING DENSITY

PS = SHORT SPACING DENSITY

FIG.10D-1

$$\Delta CR_{TOP} = A \sqrt{G^2_{MEAS_{TOP}} - G^2_{THEOR_{TOP}}}$$

$$\Delta PROT_{TOP} = (ds) \left[\ln \left(\frac{CR_{TOP} + \Delta CR_{TOP}}{CR_{TOP} - \Delta CR_{TOP}} \right) \right]$$

$$P_{bROT_{TOP}} = DP_{L_{TOP}} + EPS_{TOP} + F \Delta PROT_{TOP}$$

PL TOP = LONG SPACING DENSITY TOP

PS TOP = SHORT SPACING DENSITY TOP

FIG.10D-2

FIG.11A

330

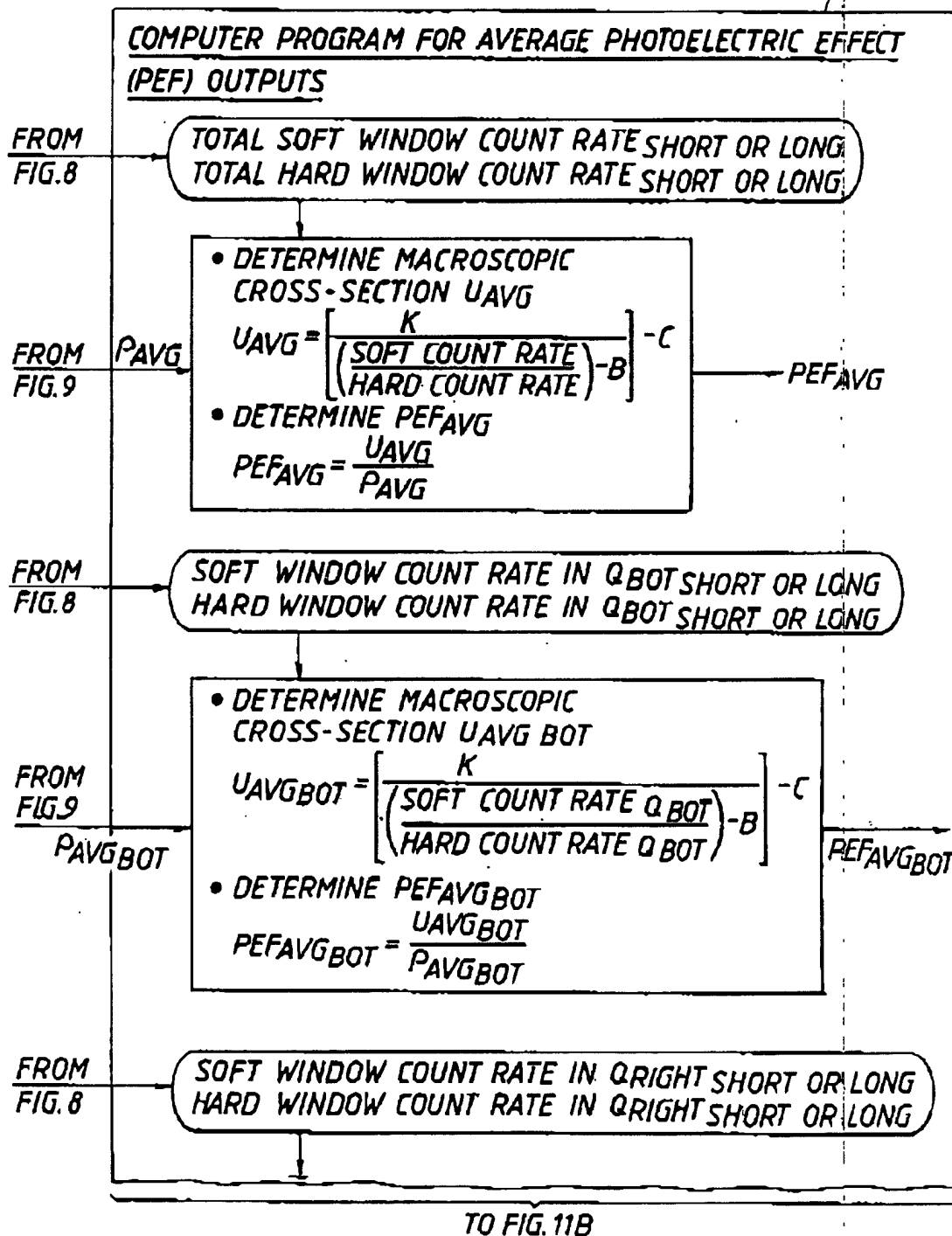


FIG. 11B

FROM FIG. 11A

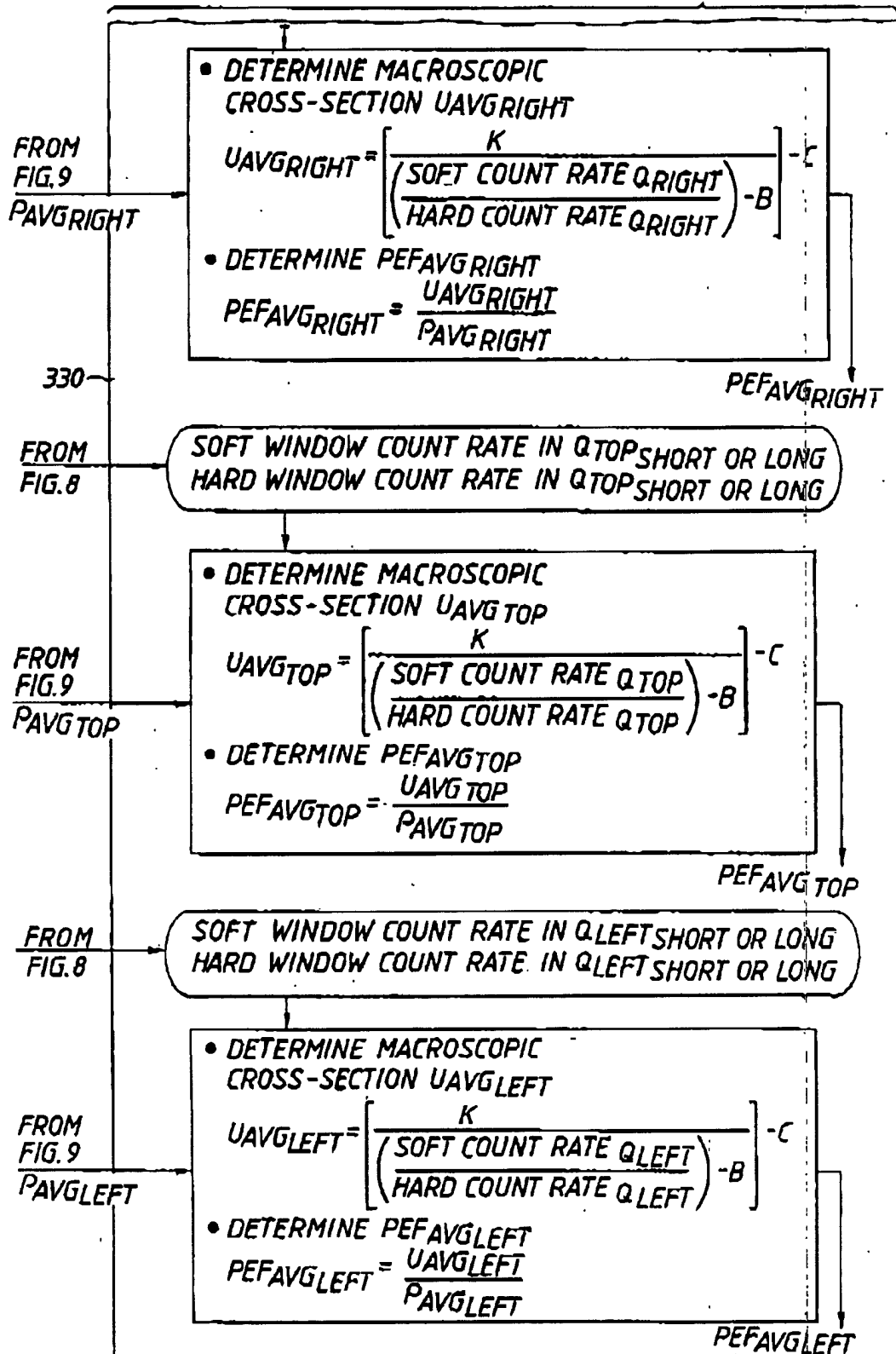


FIG. 12A

335

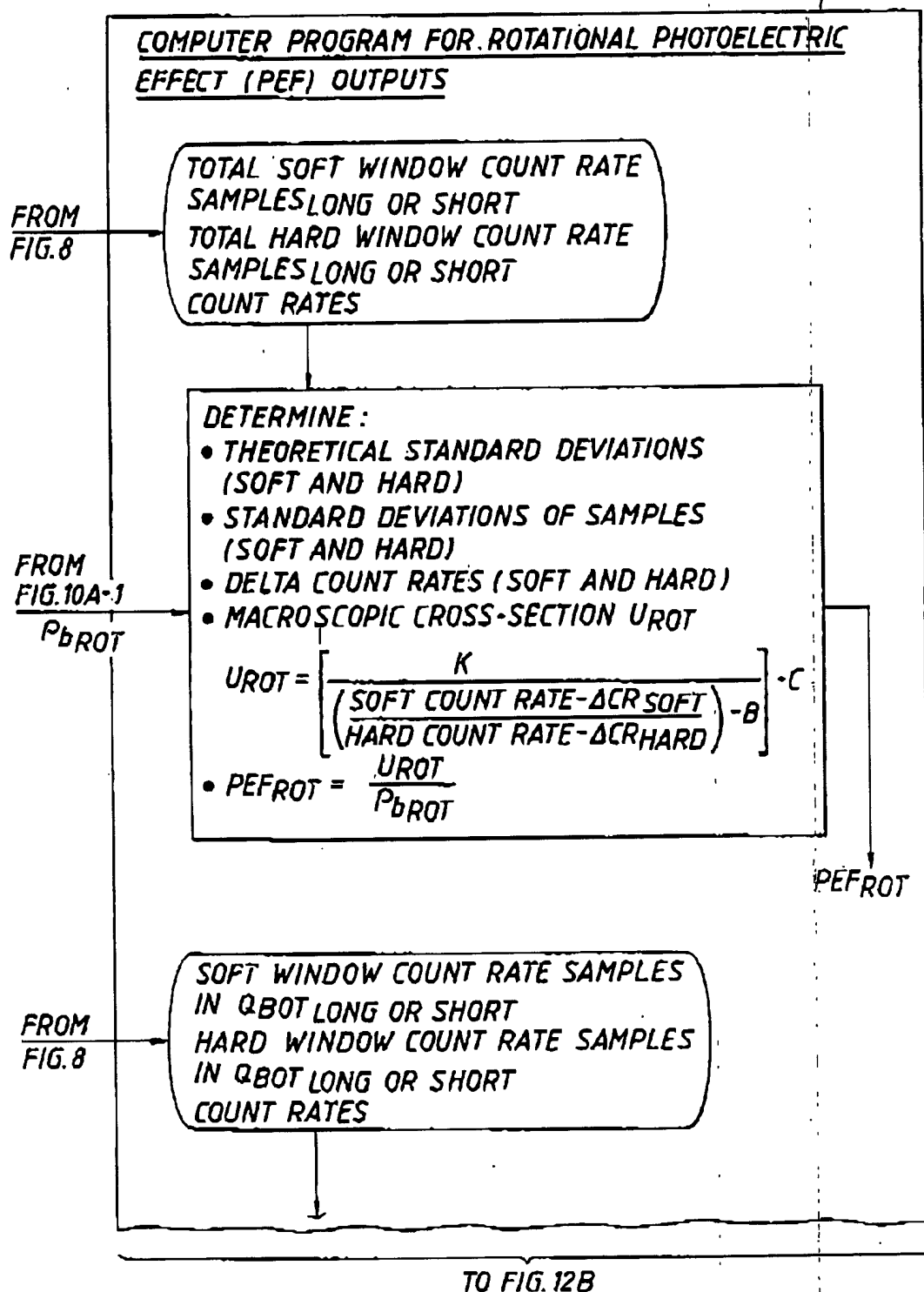


FIG. 12

FROM FIG. 12A

FROM
FIG. 10A-1
 $P_{bROT BOT}$

DETERMINE:

- THEORETICAL STANDARD DEVIATIONS (SOFT AND HARD)
- STANDARD DEVIATIONS OF SAMPLES (SOFT AND HARD)
- DELTA COUNT RATES (SOFT AND HARD)
- MACROSCOPIC CROSS-SECTION $U_{ROT BOT}$

$$U_{ROT BOT} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE} - \Delta CR_{SOFT}}{\text{HARD COUNT RATE} - \Delta CR_{HARD}} \right)^B} \right]^{-C}$$

$$\bullet \text{ PEFROT BOT} = \frac{U_{ROT BOT}}{P_{bROT BOT}}$$

335

PEFROT BOT

FROM
FIG. 8

SOFT WINDOW COUNT RATE SAMPLES
IN QRIGHT LONG OR SHORT
HARD WINDOW COUNT RATE SAMPLES
IN QRIGHT LONG OR SHORT
COUNT RATES

FROM
FIG. 10A-2
 $P_{bROT RIGHT}$

DETERMINE:

- THEORETICAL STANDARD DEVIATIONS (SOFT AND HARD)
- STANDARD DEVIATIONS OF SAMPLES (SOFT AND HARD)
- DELTA COUNT RATES (SOFT AND HARD)
- MACROSCOPIC CROSS-SECTION $U_{ROT RIGHT}$

$$U_{ROT RIGHT} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE} - \Delta CR_{SOFT}}{\text{HARD COUNT RATE} - \Delta CR_{HARD}} \right)^B} \right]^{-C}$$

$$\bullet \text{ PEFROT RIGHT} = \frac{U_{ROT RIGHT}}{P_{bROT RIGHT}}$$

PEFROT RIGHT

FROM
FIG. 8

SOFT WINDOW COUNT RATE SAMPLES
IN QTOP LONG OR SHORT
HARD WINDOW COUNT RATE SAMPLES
IN QTOP LONG OR SHORT
COUNT RATES

TO FIG. 12C

FIG. 12

FROM FIG. 12B

FROM
FIG. 10A-2 $P_{bROT TOP}$ **DETERMINE:**

- THEORETICAL STANDARD DEVIATIONS (SOFT AND HARD)
- STANDARD DEVIATIONS OF SAMPLES (SOFT AND HARD)
- DELTA COUNT RATES (SOFT AND HARD)
- MACROSCOPIC CROSS-SECTION $U_{ROT TOP}$

$$U_{ROT TOP} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE} - \Delta CR_{SOFT}}{\text{HARD COUNT RATE} - \Delta CR_{HARD}} \right)^{-B}} \right]^{-C}$$

$$\bullet \text{ PEFROT TOP} = \frac{U_{ROT TOP}}{P_{bROT TOP}}$$

335

PEFROT TOP

FROM
FIG. 8

SOFT WINDOW COUNT RATE SAMPLES
IN $Q_{LEFT LONG}$ OR SHORT
HARD WINDOW COUNT RATE SAMPLES
IN $Q_{LEFT LONG}$ OR SHORT
COUNT RATES

FROM
FIG. 10A-2 $P_{bROT LEFT}$ **DETERMINE:**

- THEORETICAL STANDARD DEVIATIONS (SOFT AND HARD)
- STANDARD DEVIATIONS OF SAMPLES (SOFT AND HARD)
- DELTA COUNT RATES (SOFT OR HARD)
- MACROSCOPIC CROSS-SECTION $U_{ROT LEFT}$

$$U_{ROT LEFT} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE} - \Delta CR_{SOFT}}{\text{HARD COUNT RATE} - \Delta CR_{HARD}} \right)^{-B}} \right]^{-C}$$

$$\bullet \text{ PEFROT LEFT} = \frac{U_{ROT LEFT}}{P_{bROT LEFT}}$$

PEFROT LEFT

FIG. 12D

335

COMPUTER PROGRAM FOR ROTATIONAL PHOTOELECTRIC EFFECT (PEF) OUTPUTS

FROM
FIG. 8

TOTAL SOFT WINDOW COUNT RATE SAMPLES LNG. OR SHT.
TOTAL HARD WINDOW COUNT RATE SAMPLES LNG. OR SHT.
ACQUISITION TIME SAMPLES

- DETERMINE MACROSCOPIC CROSS-SECTION U_t 's AS A FUNCTION OF ACQUISITION TIME

$$U_t = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE}}{\text{HARD COUNT RATE}} \right)^{-B}} \right]^{-C}$$

- DETERMINE STANDARD DEVIATION FROM U_t 's
- DETERMINE PEF_{ROT} FROM DISTRIBUTION OF U_t 's

PEF_{ROT}

FROM
FIG. 8

SOFT WINDOW COUNT RATE SAMPLES IN QBOT LNG. OR SHT.
HARD WINDOW COUNT RATE SAMPLES IN QBOT LNG. OR SHT.
ACQUISITION TIME SAMPLES

- DETERMINE MACROSCOPIC CROSS-SECTION U_{tBOT} 's AS A FUNCTION OF ACQUISITION TIME

$$U_{tBOT} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE}}{\text{HARD COUNT RATE}} \right)^{-B}} \right]^{-C}$$

- DETERMINE STANDARD DEVIATION FROM U_{tBOT} 's
- DETERMINE PEF_{ROTBOT} FROM DISTRIBUTION OF U_{tBOT} 's

PEF_{ROTBOT}

TO FIG. 12E

FIG.12E

FROM FIG.12D

FROM
FIG. 8

SOFT WINDOW COUNT RATE SAMPLES IN Q_{RIGHT} LNG. OR SHT.
HARD WINDOW COUNT RATE SAMPLES IN Q_{RIGHT} LNG. OR SHT.
ACQUISITION TIME SAMPLES

335

- DETERMINE MACROSCOPIC CROSS-SECTION U_{RIGHT}'s AS A FUNCTION OF ACQUISITION TIME

$$U_{RIGHT} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE}}{\text{HARD COUNT RATE}} \right)^{-B}} \right]^{-C}$$

- DETERMINE STANDARD DEVIATION FROM U_{RIGHT}'s
- DETERMINE PEFROT_{RIGHT} FROM DISTRIBUTION OF U_{RIGHT}'s

PEFROT_{RIGHT}FROM
FIG. 8

SOFT WINDOW COUNT RATE SAMPLES IN Q_{TOP} LNG. OR SHT.
HARD WINDOW COUNT RATE SAMPLES IN Q_{TOP} LNG. OR SHT.
ACQUISITION TIME SAMPLES

- DETERMINE MACROSCOPIC CROSS-SECTION U_{TOP}'s AS A FUNCTION OF ACQUISITION TIME

$$U_{TOP} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE}}{\text{HARD COUNT RATE}} \right)^{-B}} \right]^{-C}$$

- DETERMINE STANDARD DEVIATION FROM U_{TOP}'s
- DETERMINE PEFROT_{TOP} FROM DISTRIBUTION OF U_{TOP}'s

PEFROT_{TOP}

TO FIG.12F

FIG. 12F

FROM FIG. 12E

FROM
FIG. 8

SOFT WINDOW COUNT RATE SAMPLES IN QLEFT LNG. OR SHT.
HARD WINDOW COUNT RATE SAMPLES IN QLEFT LNG. OR SHT.
ACQUISITION TIME SAMPLES

335

- DETERMINE MACROSCOPIC CROSS-SECTION U_{LEFT} 's AS A FUNCTION OF ACQUISITION TIME

$$U_{LEFT} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE}}{\text{HARD COUNT RATE}} \right) - B} \right] - C$$

- DETERMINE STANDARD DEVIATION FROM U_{LEFT} 's
- DETERMINE PEF_{ROT_LEFT} FROM DISTRIBUTION OF U_{LEFT} 's

PEF_{ROT}LEFT

FIG. 13

350

COMPUTER PROGRAM FOR ULTRASONIC STANDOFF OUTPUTS

FROM
FIG. 4A-B

- RECORD STANDOFF AS A FUNCTION OF QUADRANT
- DEVELOP HISTOGRAM OF ALL STANDOFFS AND HISTOGRAM OF STANDOFFS PER QUADRANT
- DETERMINE STANDOFFAVG, STANDOFFMAX, STANDOFFMIN FOR EACH QUADRANT
- DETERMINE HOLE SHAPE:
HORIZONTAL DIAMETER
VERTICAL DIAMETER

H DIAMETER

V DIAMETER

FIG. 14A

340

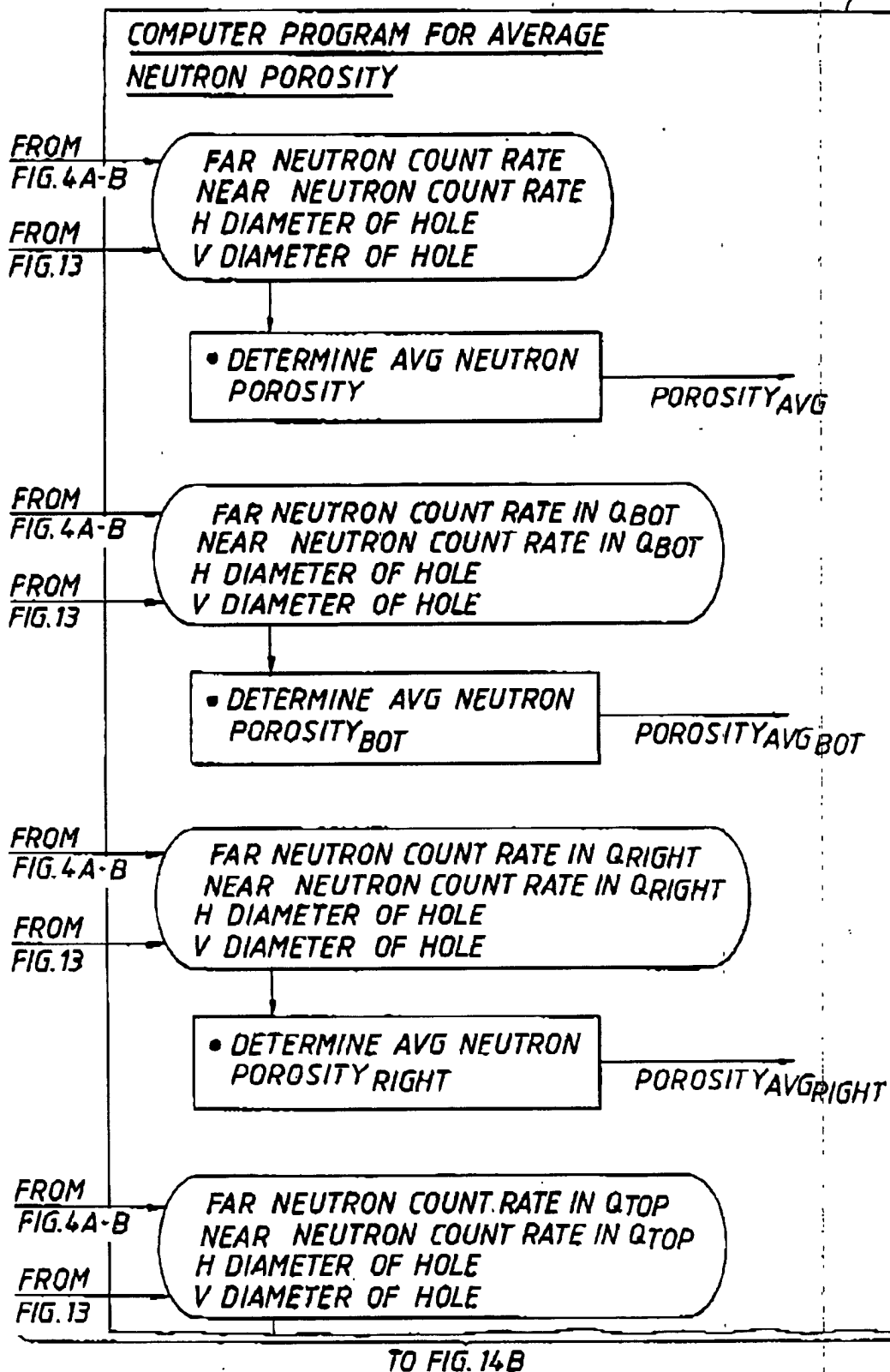


FIG. 14B

FROM FIG. 14A

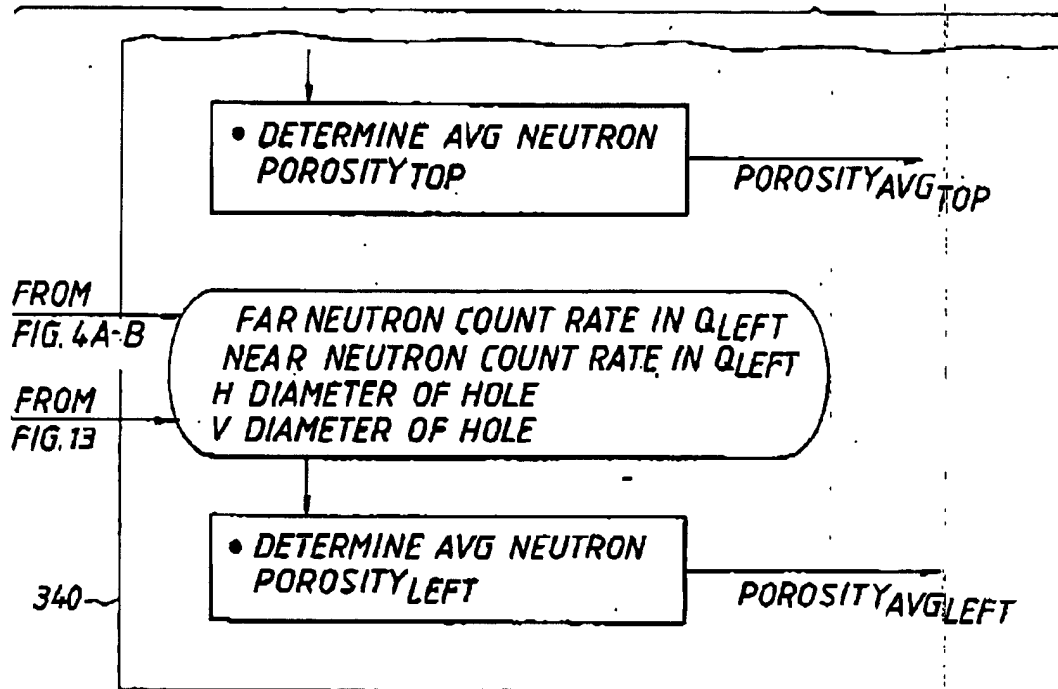


FIG. 15A

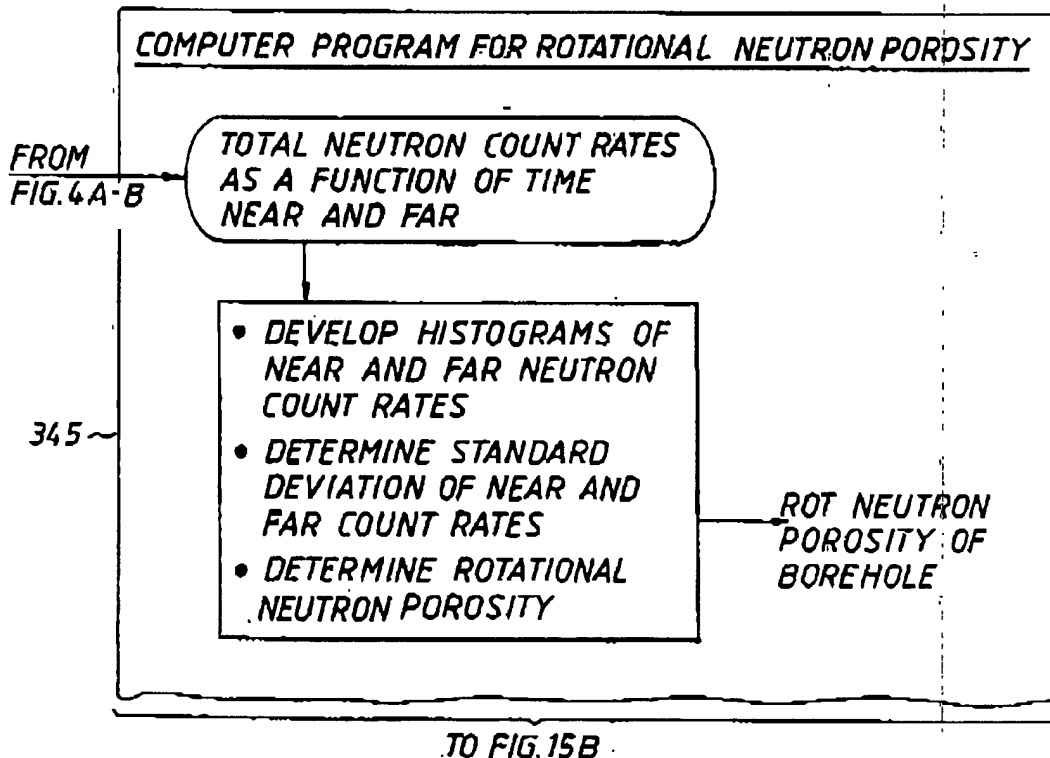


FIG.15B

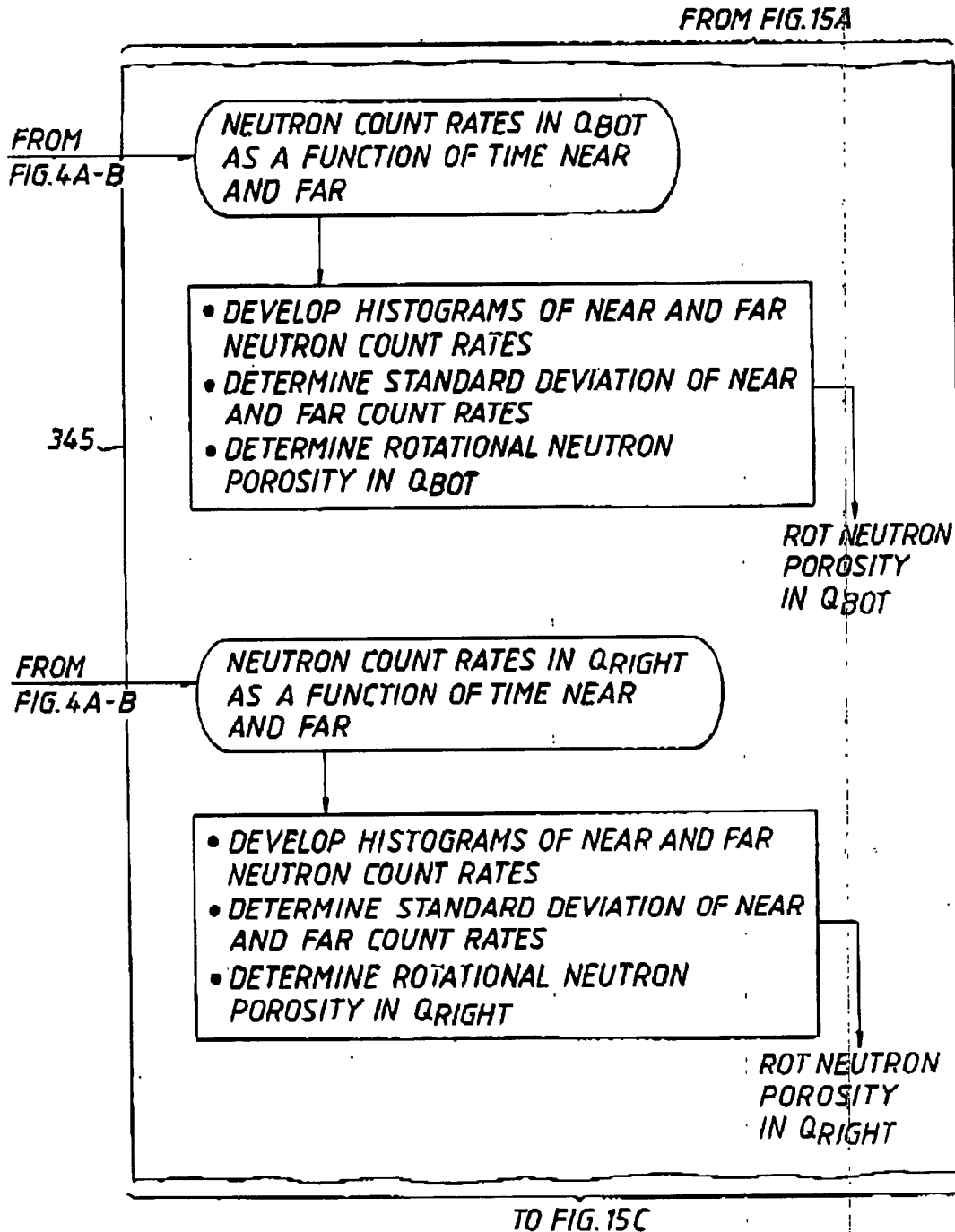
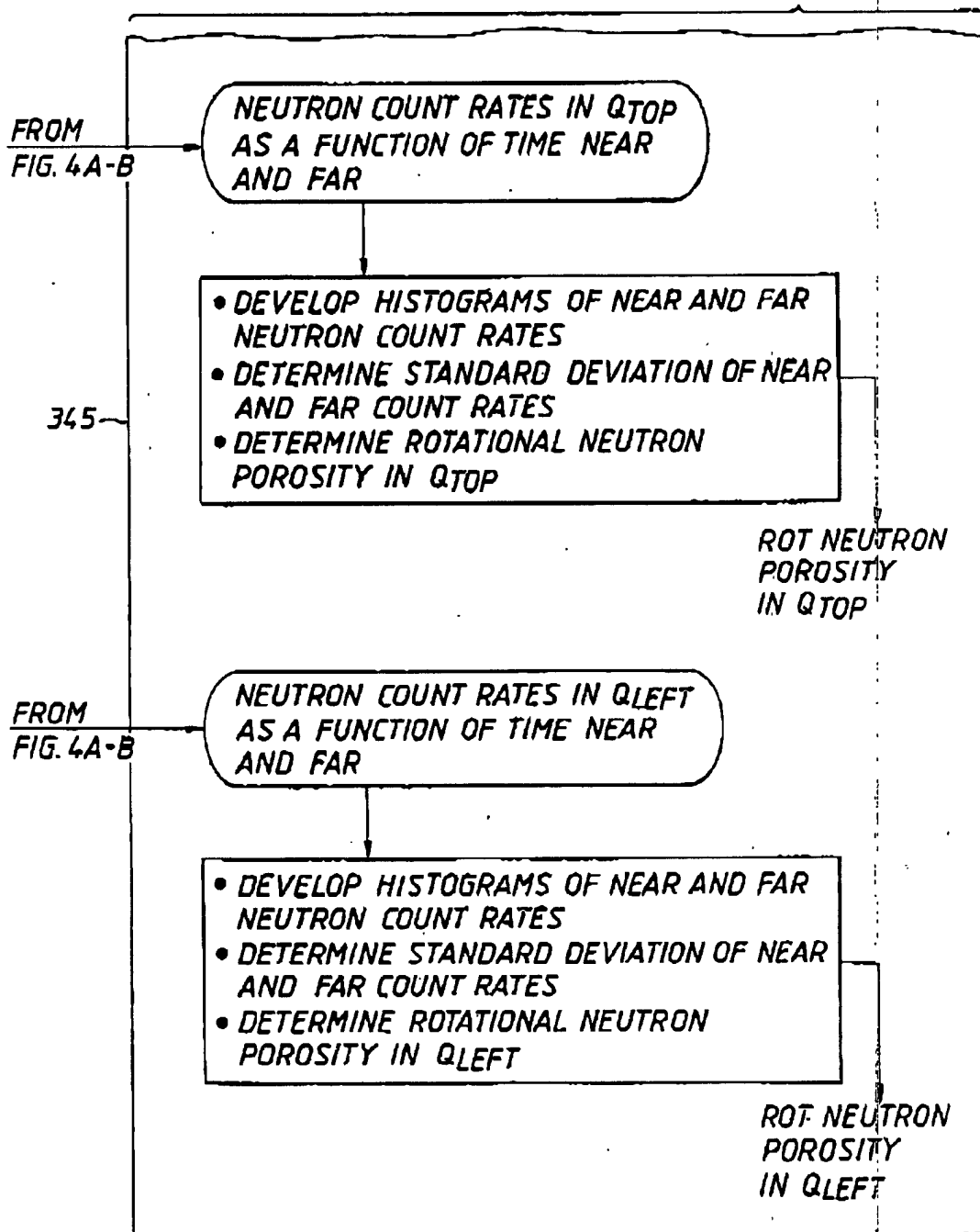


FIG. 15C

FROM FIG. 15B



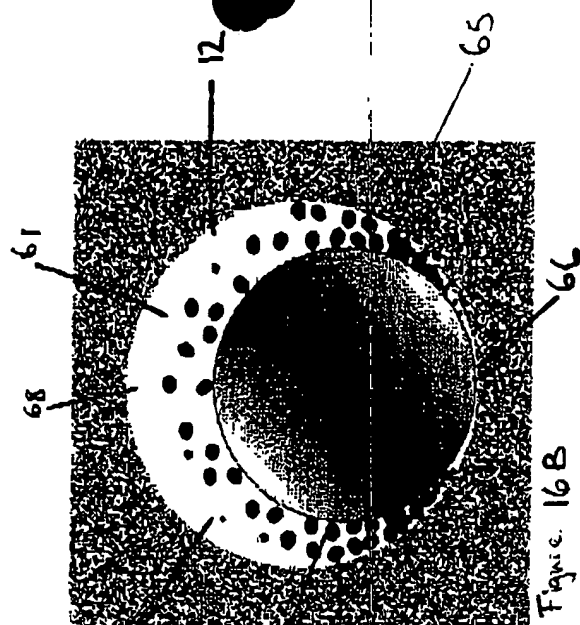


Figure 16B

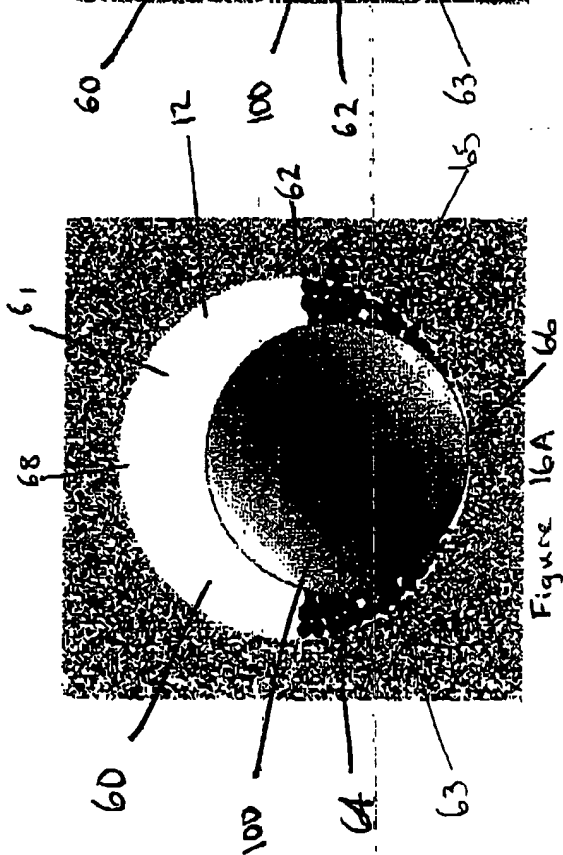


Figure 16A

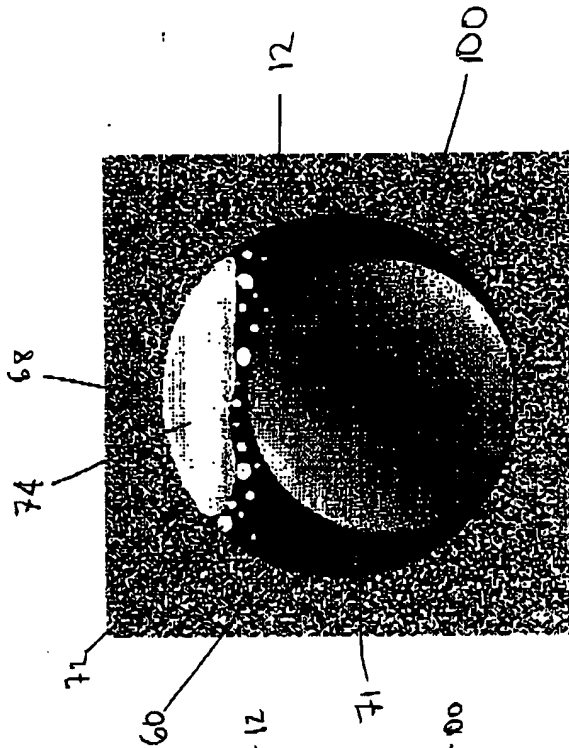


Figure 17A

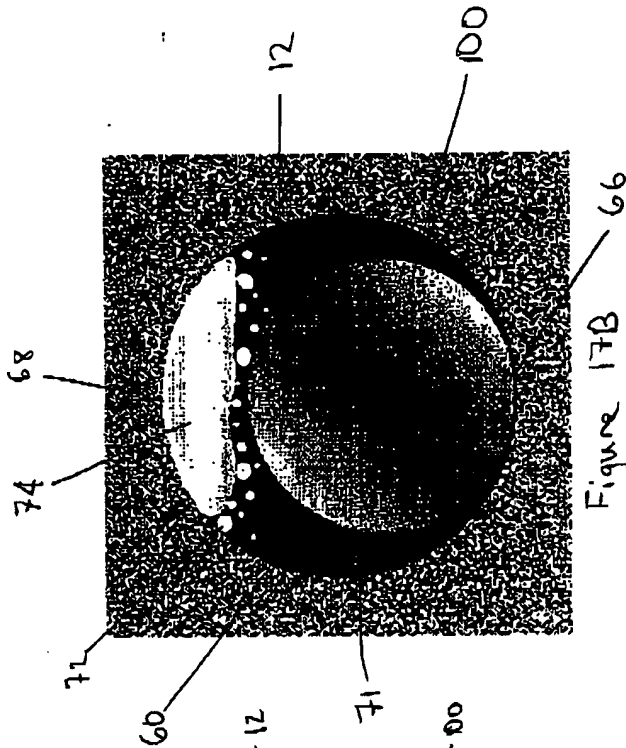


Figure 17B